180132

FLOOD INSURANCE STUDY

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CITY OF GARY, INDIANA

LAKE COUNTY

SEPTEMBER 16, 1980

federal emergency management agency
federal insurance administration

COMMUNITY NUMBER - 180132

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Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY

CITY OF GARY,
LAKE COUNTY, INDIANA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Gary, Lake County, Indiana, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the City of Gary to the regular program of flood insurance by the Federal Insurance Administration (FIA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.1 (c). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by the U.S. Army Corps of Engineers, Chicago District, for the Federal Insurance Administration, under Inter-Agency Agreement No. IAA-H-7-76, Project Order No. 19. This study was completed in December 1978.

1.3 Coordination

The selection of the community base map and the identification of streams to be studied in detail were performed at a meeting held on January 5, 1976, attended by representatives of the U.S. Army Corps of Engineers (COE), the FIA, and the City of Gary.

All peak flood discharges used in this study have been reviewed and approved by the U.S. Geological Survey (USGS), the U.S. Department of Agriculture, Soil Conservation Service (SCS), and the Indiana Department of Natural Resources.

During the course of this study, flood elevations, flood boundaries, and floodway delineations were reviewed with community officials and officials of the Indiana Department of Natural Resources.

On April 10, 1980, the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by personnel of the COE, the FIA, the Indiana Department of Natural Resources, and the City of Gary.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Gary. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction through 1981.

Approximate methods of analysis were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by the FIA and the City of Gary.

The flooding sources studied by detailed methods are listed below:

a. the Grand Calumet River from Oline Avenue (New) to about 1.05 miles upstream of Tennessee Street;

b. the Little Calumet River from the Conrail railroad upstream to the corporate limit at Oline Avenue (New);

c. Lake Michigan within the community;

d. Upstream lakes on Grand Calumet River within the community; and

e. Burns Ditch (which becomes the Deep River outside the corporate limits) within the community.

Flooding along the Gary Airport Drain (NW), Drain Area-Burns Ditch (E), Cady Marsh Ditch, and Bailly School Ditch was studied by approximate methods due to the relatively undeveloped area of the flood plain and/or the minor extent of flood hazard area along their courses.

2.2 Community Description

The City of Gary is located in northwest Indiana in the northern part of Lake County. Gary borders Lake Michigan on the north; Hammond and East Chicago on the west; Porter County on the east; and Lake Station, Hobart,

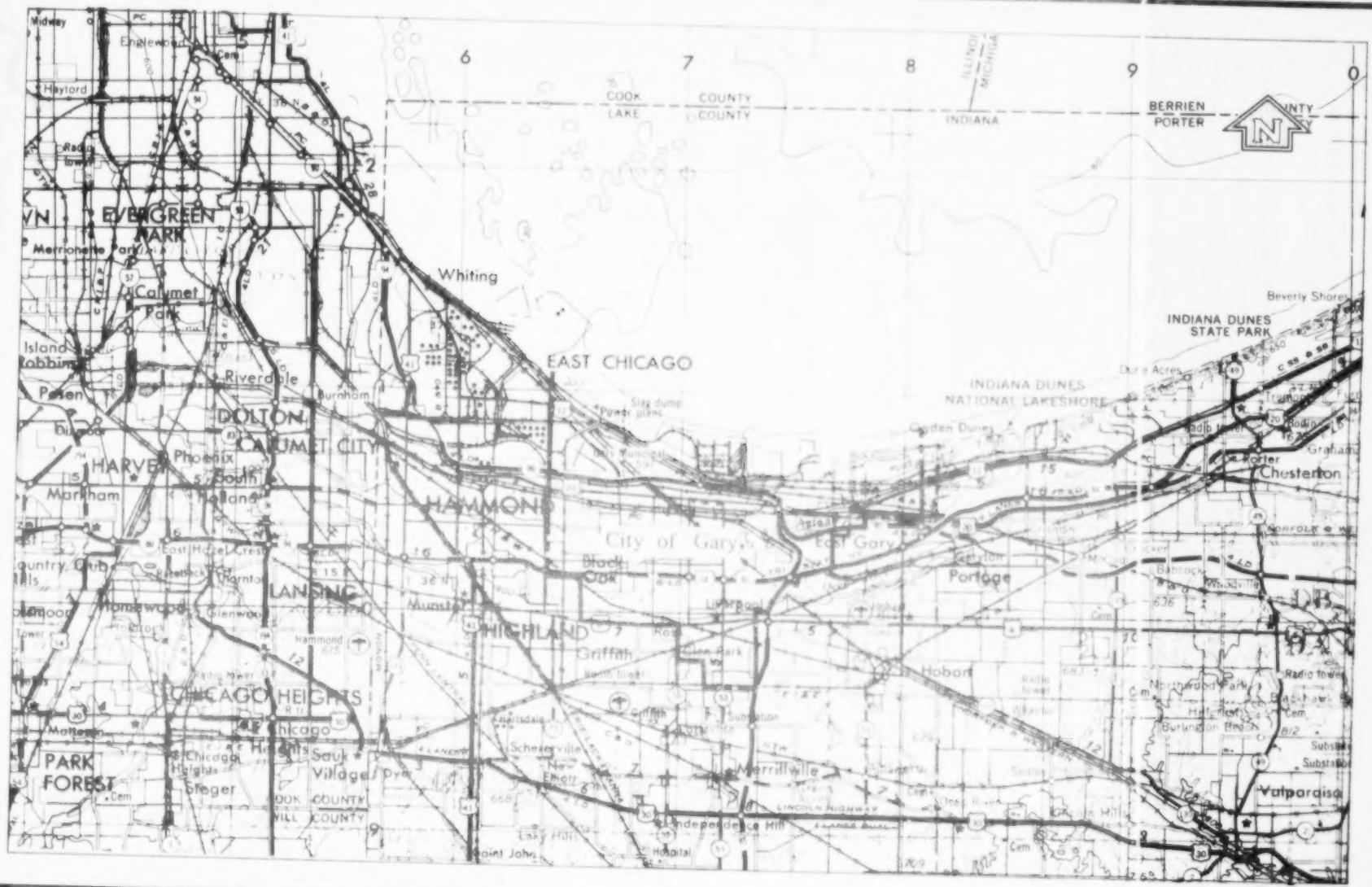

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

Federal Insurance Administration

CITY OF GARY, IN

(LAKE CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

Merrillville, and parts of unincorporated Lake County on the south. The 1970 census lists the population of Gary as 175,415, a decrease of 1.6 percent from the 1960 population of 178,320 (Reference 1).

In March 1906, U.S. Steel began the construction of a large steel manufacturing complex on the southern most tip of Lake Michigan. This land was an uninhabited region with swampy lowlands and sand dunes before construction began. In June, U.S. Steel organized and commissioned the Gary Land Company to lay out an "ideal individual town" and on July 17, the Town of Gary became incorporated. The building continued at an astonishing rate and by 1910, Gary was an industrial boom city with a population of 16,802. Between 1910 and 1920, the population continued to grow to 55,379. Other, primarily steel related industries continued to spring up in Gary's industrial section.

Monthly average temperatures for the Gary area vary from a low of 24.7 degrees Fahrenheit (F.) in January to a high of 69.6 degrees F. in July. Annual precipitation averages 50.3 inches per year (Reference 2).

The topography of most of Gary is very flat, with a maximum relief of 35 feet. The extreme northeast corner of Gary is the exception, with hills as high as 100 feet.

The principal physiographic features of the Little Calumet River basin are a result of the latest glaciation from the Lake Michigan lobe of the Wisconsin ice sheet. As this glacier receded several moraines were deposited, the most significant of these being Valparaiso Moraine which parallels the Lake Michigan shoreline and forms the southern boundary of the Little Calumet River watershed. The bedrock in the Little Calumet basin is of sedimentary origin, the uppermost units being comprised of limestone and dolomite of the Niagrian series, Silurian age (Reference 3). Soils in the basin are generally sands and scattered muck deposits underlain by massive glacial till sheets having a silty clay composition (Reference 4). Because of the limited topographic relief in the Gary area, several wetland areas overgrown with thick grass and low-lying brush can be found. These wetlands exemplify the general sluggishness of the Little Calumet River basin discharging runoff.

The Little Calumet River rises in western LaPorte County, Indiana, and encompasses a total drainage area of approximately 587 square miles. Originally, the entire river drained to the west past the Illinois-Indiana state line, then made a sharp turn to the northeast back into Indiana, and eventually emptied into Lake Michigan at present Marquette Park in Gary. About 170 years ago, the State of Indiana opened a new channel to Lake Michigan just east of the state line. Eventually, the original mouth at Gary became clogged with vegetation and sand, causing this portion of the river, now called the Grand Calumet River, to flow westward to the new mouth. Several small lakes formed at the upstream end. The Calumet-Sag Channel was dug in 1922, partially to prevent pollution to the lake from this reverse

flow; hence, flows from the Little Calumet River west of Hart Ditch now empty into the Calumet-Sag Channel and continue westward to the Chicago Sanitary and Ship Canal.

Present land uses in Gary are primarily industrial and residential with some commercial and open space uses evident. The iron, steel, sheet, and tin plate mills and cement plants are among the largest in the world today. Other products manufactured in Gary include auto bodies and accessories, plastics, jet engines, and clothing. This manufacturing is mostly confined to the area between the Grand Calumet River and Lake Michigan. The residential areas are south of the Grand Calumet River. Most of the Little Calumet River flood plain is residential and open space area with most of the Grand Calumet River flood plain being open space. Lake Michigan does not have a significant flood plain. Gary has developed an excellent network of transportation facilities with three interstate highways, numerous railroad lines, and a deep draft harbor on Lake Michigan.

2.3 Principal Flood Problems

The Little Calumet River, the main source of flooding problems in Gary, is subject to floods as a result of heavy runoffs on its tributaries. Snowmelt over the basin in the spring causes the streams to rise and the flat low-lying portions of the Little Calumet River valley are flooded for several days or, in some instances, even weeks. Prolonged flood duration is also caused by inadequate channel capacity which forces a large part of the water into temporary storage. Major floods have occurred in March 1908, March 1944, April 1947, March 1948, May 1948, October 1954, and July 1957. Lesser floods have occurred in 68 other instances since 1907. Flooding from Lake Michigan is caused by a combination of high lake levels and wind setup effect. The Grand Calumet River does not have a major flooding problem since most of flow in the river is industrial cooling and processing water and waste treatment plant effluents.

Past floods in Gary have caused extensive damage to residential, commercial, and public properties. Damages include deposition of debris silt and slime; water damage to buildings, contents, and grounds; and damage to foundation and basement floors due to hydraulic pressures and settling. A health hazard is created by the backup of sanitary sewers. Hazard to life is minimal since flooding is shallow, although a large levee failure could catch people off guard and prove disastrous.

The flood problems in the Little Calumet River basin arise from both stream overflow and from inadequate storm drainage systems. The damage due to the latter condition can be corrected only by major reconstruction of existing storm drains, the installation of sump pumps in individual basements, and extensions of storm drains to those areas which now have none. The flood problem is complicated by the extreme flatness of the area causing sluggish passage of floodwaters. The large amount of development

in this basin has left little space for the construction of flood protective works. This development has also increased the amount of hard surface area, such as roads, sidewalks, roofs, etc., causing greater runoff. Channel constrictions, such as bridges with insufficient floodway area, collect debris and inhibit the passage of floodwaters. Another problem is created by levees which were built without allowing sufficient channel capacities. These increase the flood stages.

Due to the overbank flooding of the Little Calumet River in October 1954, about 100 families were evacuated from Gary's Riley Village near 44th Avenue and Louisiana Place. The water was as deep as 3 to 4 feet in some homes (Reference 5).

2.4 Flood Protection Measures

The construction of Burns Ditch and Waterway was completed in 1926 at a cost of about $1,000,000. Burns Waterway provides an outlet from the Little Calumet River to Lake Michigan about 10 miles east of Gary. Burns Ditch extends approximately west in the course of the Little Calumet River from Burns Waterway to Deep River, and the Salt Creek Arm continues east of the waterway. Burns Ditch and Waterway were later redredged at a cost of $75,000 by the City of Gary and adjoining communities.

Under the Works Projects Administration (WPA) projects sponsored by Gary and Hammond, in Indiana, and the Illinois Division of Waterways from 1933 to 1936, the Little Calumet River was cleaned, deepened, and widened. Numerous reaches of levees have been constructed. In general, such levees are of inadequate cross section and afford protection against only lesser floods.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten), and for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of

completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

The Little Calumet River hydrology is affected by many complicating factors, such as: (1) split flow direction at Hart Ditch and Deep River, (2) large reduction of flows as the floodwaters proceed downstream and spread over a large area, and (3) numerous spoil bank and other types of construction which inhibit the passage of floodwater and remove storage volume. The HEC-1 computer model was chosen to develop the basin hydrology (Reference 6). The HEC-1 model was also used to compute stages for upstream lakes on the Grand Calumet River. The HEC-1 model relates basin characteristics and rainfall data to stream discharge. The basin characteristics include vegetation, topography, amount and nature of development, and soil types. Rainfall data were generated by a statistical analysis of rain gage records. Six-hour increments of a 24-hour storm rainfall, corresponding to frequencies of 10, 50, and 100 years, were obtained from U.S. Weather Bureau Technical Paper No. 40 (Reference 7). Rainfall values for the 500-year storm were then extrapolated from values for the lower three frequencies. Sets of these rainfall increments were entered into the HEC-1 model in critical order to obtain peak discharges for the 10-, 50-, 100-, and 500-year floods.

The modified Puls routing method reduced the flows in the stream to compensate for the large quantities of water which will be stored in the overbank areas (Reference 8). This flow reduction was based on storage-discharge relationships developed from the HEC-2 hydraulic analysis (Reference 9).

The proportioning of the split flows from Hart Ditch was done by analyzing gage records on Hart Ditch and the Little Calumet River. The periods of record for the gages are 20 years for the gage at the Little Calumet River in Gary and 36 years for the gage near the mouth of Hart Ditch. Flow records were statistically analyzed using log-Pearson Type III distributions with expected probability (Reference 8). Discharge-frequency curves were developed using the regional skew -0.2 recommended by the State of Indiana. The HEC-1 model was also used to develop discharge values for the Grand Calumet River (Reference 6).

Discharge values for Burns Ditch and the Deep River were taken from the Lake Station Flood Insurance Study (Reference 10).

Flood elevations for flooding along the Lake Michigan shoreline were computed by the Detroit District COE (Reference 11). Wave runup caused by storm waves meeting the shore is not included in the open coast flood levels discussed in this study. Historic records of water levels on Lake Michigan have been gathered at 7 gaging stations. The periods of record vary from 14 to 74 years. Frequency curves of the adjusted annual flood levels at all the gaging stations were computed analytically by use of the moments of the levels: the mean, standard deviation, and skew coefficient. Using a skew coefficient of zero, the 10, 2, 1, and 0.2 percent values from the log-Pearson Type III frequency curve were computed for the 10-, 50-, 100-, and 500-year flood levels at each station. These flood elevations are listed in Table 1, Summary of Elevations.

TABLE 1 - SUMMARY OF ELEVATIONS

LOCATION	ELEVATIONS (NGVD) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
LAKE MICHIGAN				
At Gary	583.0	583.9	584.2	584.8
UPSTREAM LAKES ON GRAND CALUMET RIVER				
At Gary	589.3	589.9	590.1	590.6

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 2.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

Cross section data for streams in the area were obtained from field surveys. All bridges and culverts along the streams studied in detail were surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

TABLE 2 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
GRAND CALUMET RIVER					
Colfax Street	16.14	2,825	3,230	3,380	3,740
Norfolk and Western Railway	10.46	2,315	2,570	2,660	2,875
Polk Street	6.09	1,560	1,750	1,820	2,005
Rhode Island Street	4.55	1,085	1,140	1,160	1,220
Downstream Rhode Island Street	1.38	155	185	200	230
LITTLE CALUMET RIVER *					
Cline Avenue	75.8	1,195	1,335	1,390	1,520
Chase Street	84.1	320	585	640	735
Conrail	88.2	300	370	430	555
BURNS DITCH					
At Gary	160	2,645	4,040	4,640	6,170
At Interstate Highways 80 and 90	166	2,740	4,180	4,800	6,380
DEEP RIVER **					
Above Little Calumet River	151	3,140	4,790	5,500	7,315

* Drainage areas are approximate due to interbasin flow on the Little Calumet River.

** Information was obtained from the Lake Station, Indiana, Flood Insurance Study (Reference 10).

Roughness coefficients (Manning's "n") were estimated from field inspections at cross locations, and from model calibrations based on high water marks. Roughness values for the Little Calumet River range from 0.025 to 0.035 in the main channel and from 0.07 to 0.09 in the overbanks. Roughness values for the Grand Calumet River range from 0.030 to 0.035 in the main channel and from 0.045 to 0.060 in the overbanks.

Water-surface profiles were computed through use of the COE HEC-2 step-backwater computer program (Reference 9). In order to perform a detailed study of the Grand Calumet River it was necessary to divide the river into three separate segments and analyize each individually because of the unusual flow characteristics. The east segment begins in Gary and flows west into Indiana Harbor Canal. The middle segment which lies between Indiana Harbor Canal and Columbia Avenue has a varying direction of flow depending on stream conditions. The segment between Columbia Avenue and the Illinois-Indiana state line flows west into the Little Calumet River. Only the east segment analysis pertains to this study. The elevation of the headwaters of the Indiana Harbor Canal, determined in the City of East Chicago, Indiana, Flood Insurance Study (Reference 12), was used as the starting elevation for the eastern segment of the Grand Calumet River.

Starting water-surface elevations for the Little Calumet River were determined using stage frequency analysis of gage records for the Deep River at Munster and Gary. The section of the Little Calumet River considered in this study flows east from Hart Ditch in Hammond, Indiana, to the Deep River just outside the east corporate limits of Gary. The Deep River changes names to Burns Ditch about 800 feet upstream of Interstate 80-94. Rating curves were developed for the gages on the Little Calumet River. Storm hydrographs were statistically developed at the gage on Hart Ditch in Munster. The discharges at the gages were used to compute stages to use as starting water-surface elevations for the HEC-2 step-backwater computer model. An iterative process was used to balance the HEC-1 storage-discharge relationship at the point where Hart Ditch empties into the Little Calumet River. This process included eight points of flow reduction on the east flowing part of the river. These flow reductions are caused by the large amounts of overbank storage of floodwaters. When stage and discharge values at the three gages agreed with statistical analyses, stages for the east and west flowing parts of the Little Calumet are congruent at their headwaters. The combined flow for the two parts of the Little Calumet at the split equals the Hart Ditch inflow and the model was considered a good representation of the flood event. This method was used independently for the analysis of the 10-, 50-, 100-, and 500-year flood events, since the split in flows from Hart Ditch varies greatly with the magnitude of the flood.

Delineation of the 100-year flood for flooding sources studied by approximate methods was based on information from the USGS Flood Prone Area Maps (Reference 13), historic records, and field investigation.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are,

therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FIA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using aerial photographs at a scale of 1:4800, with a contour interval of two feet (Reference 14). These maps were also used for the delineation of approximate boundaries.

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of the FIA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The State of Indiana, however, as set down by the Indiana Flood Control Act of 1945

and the Natural Resources Commission Policy Guidelines, Section 6, adopted March 28, 1974 (Reference 15), has designated that encroachment in the flood plain is limited to that which will cause no significant increase in flood height. As a result, no more than a 0.1-foot surcharge has been delineated for this study.

The floodway recommended for the part of the Grand Calumet River included in this study was computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 3).

A meeting was held on May 3, 1979, in the Indiana Department of Natural Resources offices in Indianapolis, Indiana, to decide how to delineate the Little Calumet River floodway for the Gary, Hammond, and Munster Flood Insurance Studies. This meeting was attended by representatives of the FIA, the Indiana Department of Natural Resources, and the Chicago District COE. The standard conveyance floodway was not considered reasonable because the area is flat and the flood plain is large. Encroachments into the flood plain would reduce the overbank storage of floodwaters and raise the downstream discharges and water-surface elevations long before it would affect the conveyance of floodwater. The compromise solution described below was agreed upon by all agencies attending the meeting.

West of the confluence with Hart Ditch, the floodway will be delineated on the high spoilbanks along the river. These spoilbanks lack the structural soundness to offer protection from a major flood event, but they are considered to have hydraulic significance. Since all the water that breaches the spoilbanks would be standing water, and since the land behind the spoilbanks is now fully developed, it was decided that the most reasonable floodway delineation would be along these spoilbanks. East of the confluence with Hart Ditch, no floodway was delineated. No detailed floodway was considered the best solution for this area because a computed floodway based on storage reduction was not feasible. With this type of delineation, the State of Indiana will have the opportunity to review all development in the flood plain, and restrict harmful development. Further, the state will be able to protect the overbank storage of floodwaters without eliminating the possibility of development in the flood plain. The floodway for Burns Ditch was interpolated using information from the Lake Station, Indiana Flood Insurance Study (Reference 10).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
GRAND CALUMET RIVER							
A	8.737	131	1002	3.4	586.5	586.4	0.1
B	9.232	318	1949	1.7	587.2	587.1	0.1
C	9.601	423	2626	1.3	587.5	587.4	0.1
D	10.021	996	5969	0.4	587.6	587.5	0.1
E	10.518	335	2142	1.2	587.7	587.6	0.1
F	10.784	132	972	2.7	587.9	587.8	0.1
G	11.043	330	1865	1.4	588.2	588.1	0.1
H	11.157	165	1143	2.2	588.7	588.6	0.1
I	11.203	198	1732	1.5	589.0	588.9	0.1
J	11.677	254	1730	1.5	589.1	589.0	0.1
K	12.169	208	1738	1.5	589.5	589.4	0.1
L	12.371	459	2624	0.7	589.5	589.4	0.1
M	12.743	308	2301	0.8	589.6	589.5	0.1
N	13.189	244	1483	1.2	589.6	589.5	0.1
O	13.370	146	1114	1.6	589.6	589.5	0.1
P	13.576	89	1043	1.1	589.8	589.7	0.1
Q	13.663	127	996	1.2	589.8	589.7	0.1
R	13.951	129	1067	1.1	589.9	589.8	0.1
S	14.313	86	910	1.3	590.0	589.9	0.1
T	14.693	75	480	2.4	590.3	590.2	0.1
U	15.098	77	410	0.5	590.9	590.8	0.1
V	15.425	74	383	0.5	591.0	590.9	0.1
W	15.815	67	325	0.6	591.0	590.9	0.1
X	16.087	51	248	0.0	591.0	590.9	0.1

[1]MILES ABOVE MOUTH

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
CITY OF GARY, IN
(LAKE CO.)

FLOODWAY DATA

GRAND CALUMET RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE
BURNS DITCH AND DEEP RIVER							
A	21,498	1180	4895	1.1	597.0	596.9	0.1

[1]FEET ABOVE CORPORATE LIMITS

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
CITY OF GARY, IN
(LAKE CO.)

FLOODWAY DATA

BURNS DITCH & DEEP RIVER

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

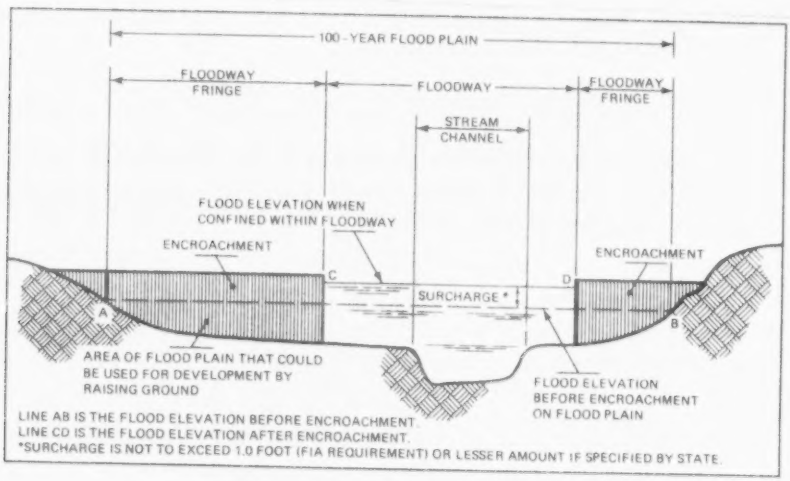
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE *
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FIA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FIGURE 2 - Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FIA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF), and flood insurance zone designations for each flooding source affecting the City of Gary.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the City of Gary are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 4).

5.2 Flood Hazard Factors

The FHF is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the City of Gary was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.

Zones A2-A6: Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to FHF.

Zone B: Areas between the Special Flood Hazard Area and the limits of the 500-year flood,

including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 4, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Gary is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FIA.

6.0 OTHER STUDIES

Flood Insurance Studies for East Chicago, Hammond, Lake Station, Hobart, and Lake County match the results of the Gary study at the Gary corporate limits (References 12, 16, 10, 17, and 18). A Flood Plain Information Report on the Little Calumet River and its tributaries was published by the COE (Reference 19). This Flood Insurance Study supersedes that Flood Plain Information Report and can be regarded as the more authoritative source of information.

A Flood Hazard Boundary Map has been published by the Federal Insurance Administration (Reference 20). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the Insurance and Mitigation Division, Federal Emergency Management Agency, One North Dearborn Street, Chicago, Illinois 60602.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
LAKE MICHIGAN							
REACH 1	0001,0003,0006 0010,0014,0017	–1.2	–0.3	0.6	010	A2	584
GRAND CALUMET RIVER							
REACH 1	0007,0011 0015,0017,0018	–0.9	–0.2	0.6	010	A2	VARIES–SEE MAP
LITTLE CALUMET RIVER							
REACH 1	0008,0012	–2.7	–1.1	1.0	025	A5	VARIES–SEE MAP
REACH 2	0012,0016	–1.9	–0.6	0.8	020	A4	VARIES–SEE MAP
REACH 3	0016,0019	–1.4	–0.2	0.4	015	A3	VARIES–SEE MAP
UPSTREAM LAKES ON GRAND CALUMET RIVER							
REACH 1	0003,0004,0007	–0.8	–0.2	0.5	010	A2	590
BURNS DITCH AND DEEP RIVER							
REACH 1[4]	0004,0005 0007,0008	–3.2	–0.9	2.7	030	A6	VARIES–SEE MAP

[1] FLOOD INSURANCE RATE MAP PANEL
[2] WEIGHTED AVERAGE
[3] ROUNDED TO NEAREST FOOT
[4] DATA FOR THIS REACH TAKEN FROM LAKE STATION, INDIANA FIS

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
CITY OF GARY, IN
(LAKE CO.)

FLOOD INSURANCE ZONE DATA

LAKE MICHIGAN - GRAND CALUMET RIVER - LITTLE CALUMET RIVER - UPSTREAM LAKES ON GRAND CALUMET RIVER - BURNS DITCH & DEEP RIVER

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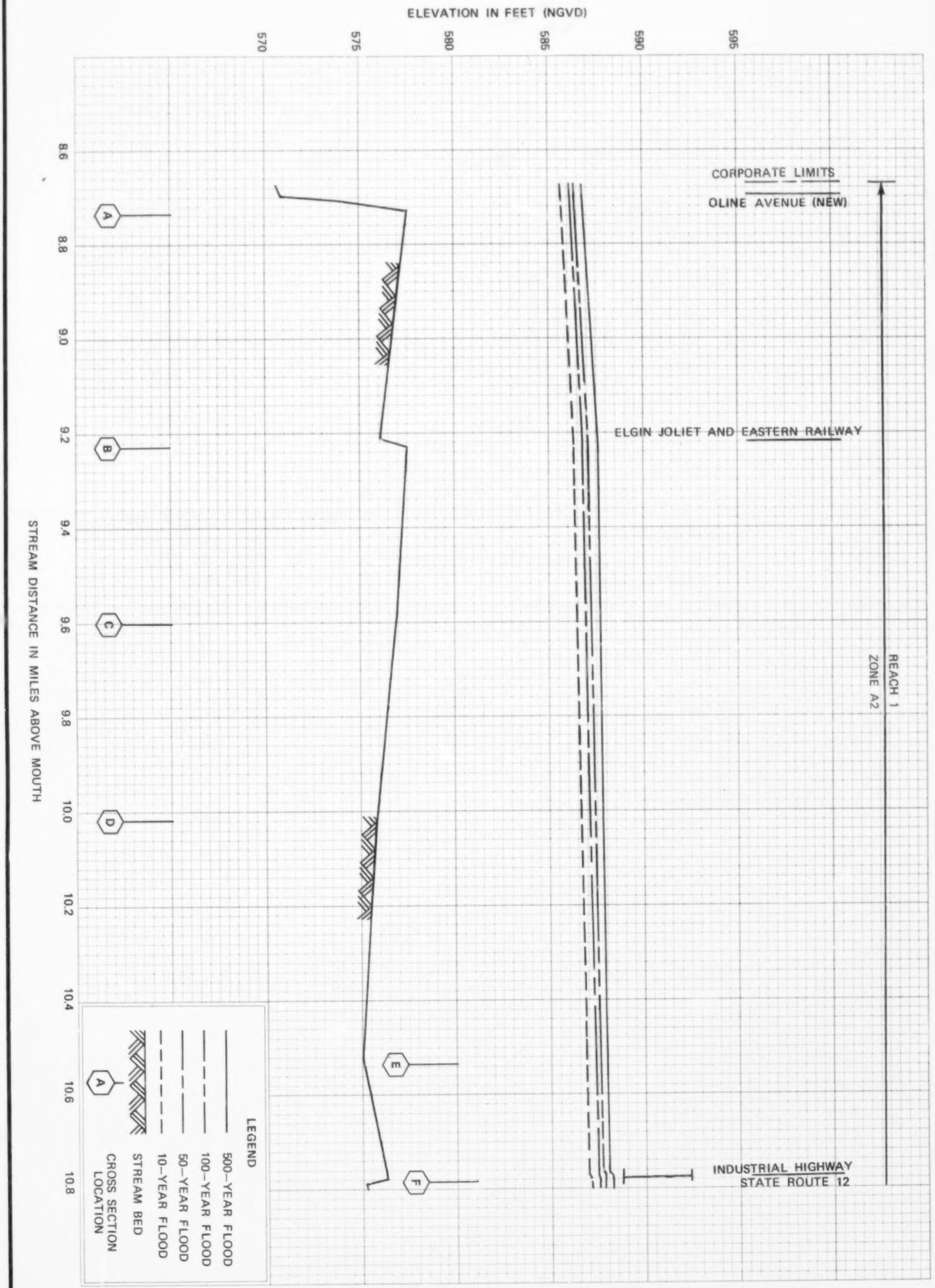

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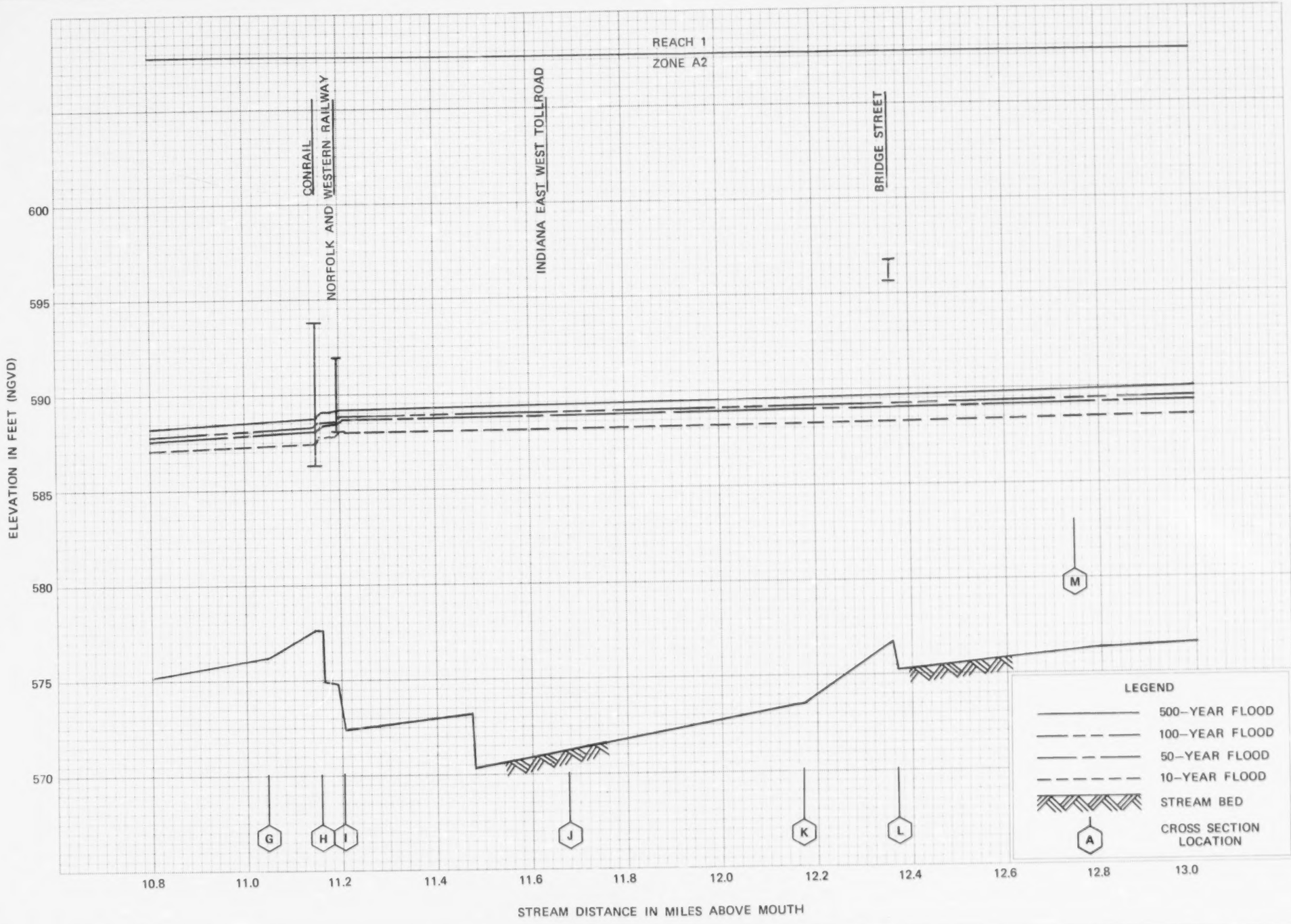
FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF GARY, IN
(LAKE CO.)

FLOOD PROFILES

GRAND CALUMET RIVER



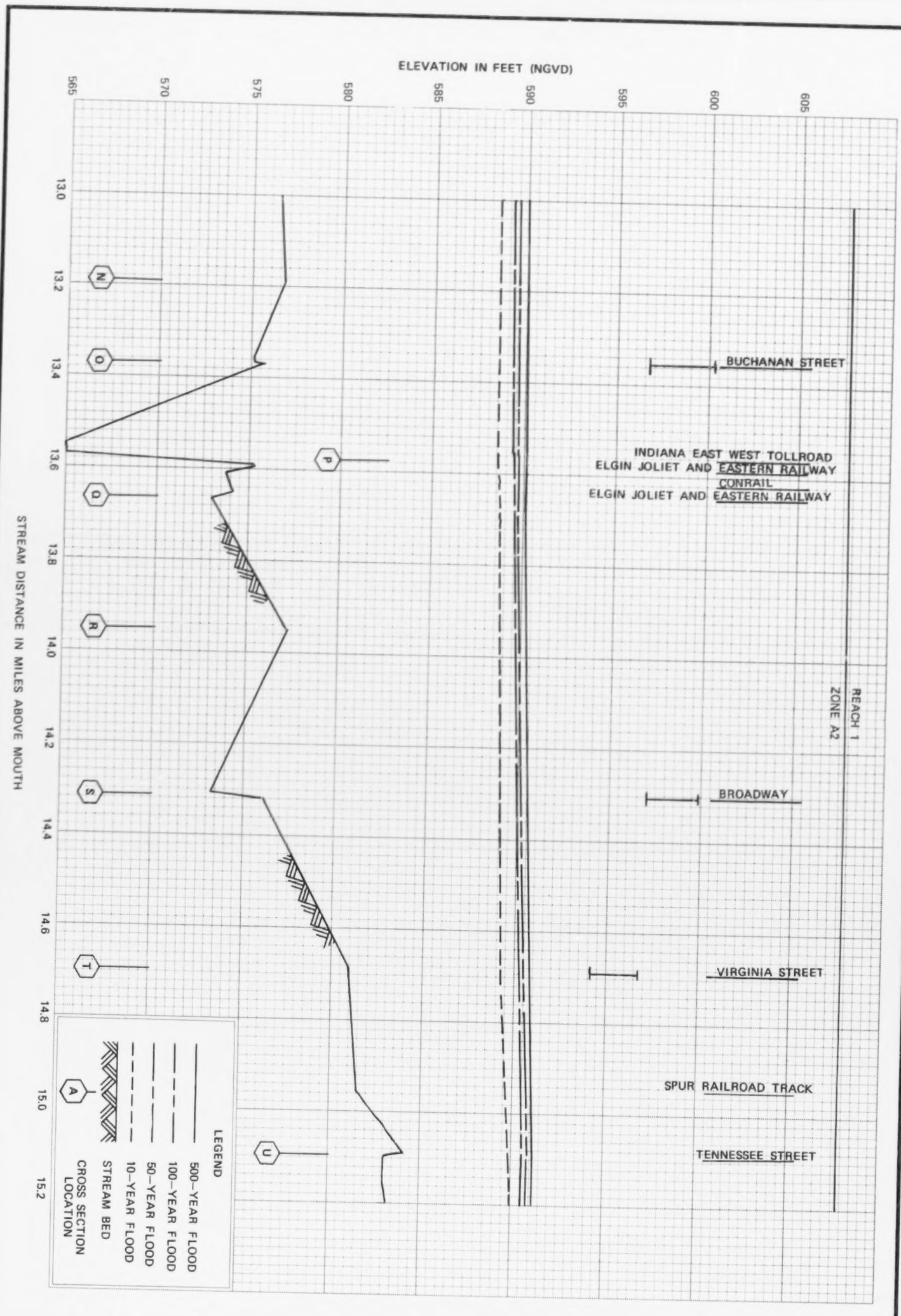
FLOOD PROFILES

GRAND CALUMET RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF GARY, IN
(LAKE CO.)

02P



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FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF GARY, IN
(LAKE CO.)

FLOOD PROFILES

GRAND CALUMET RIVER

FLOOD PROFILES

GRAND CALUMET RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF GARY, IN
(LAKE CO.)

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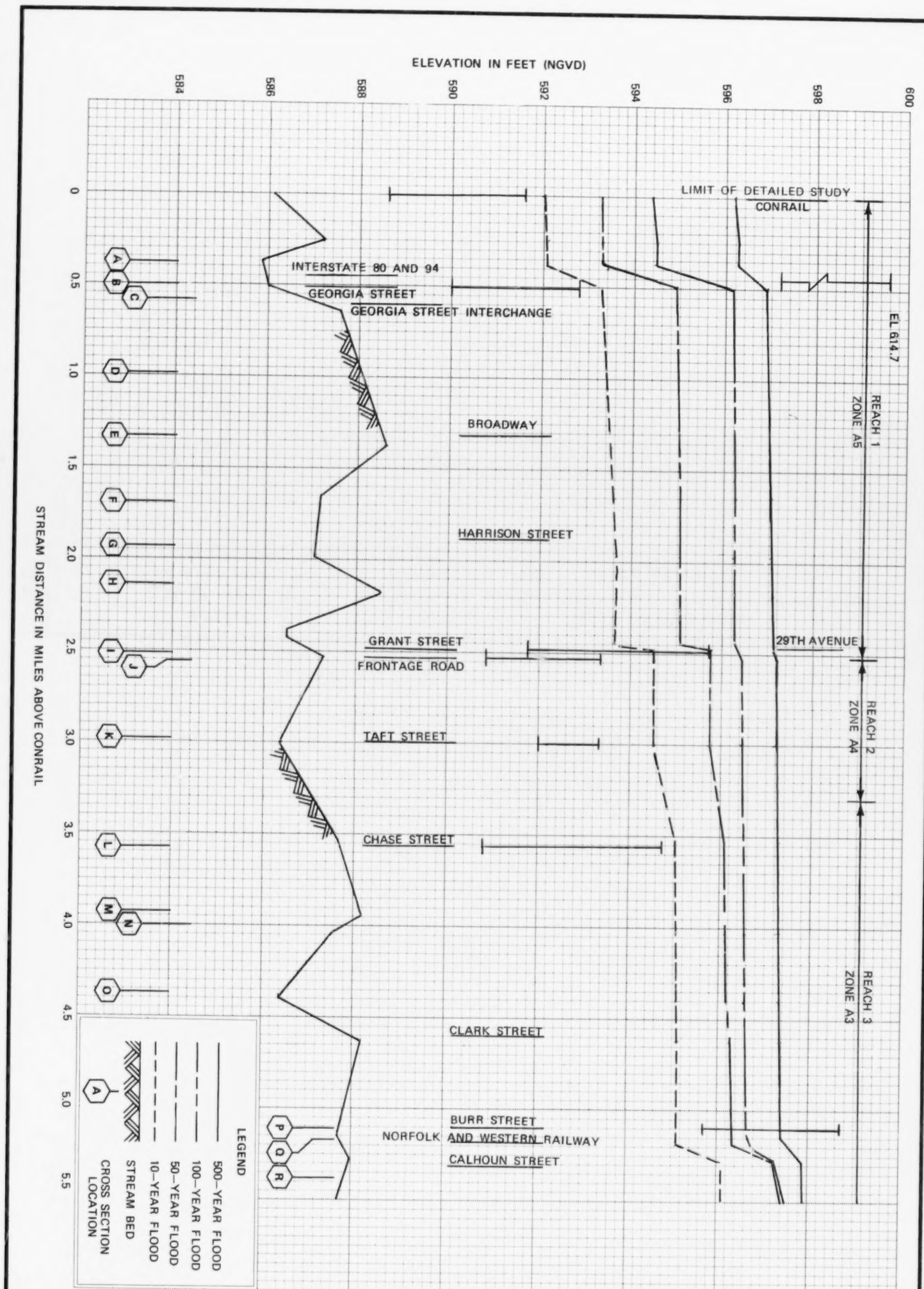

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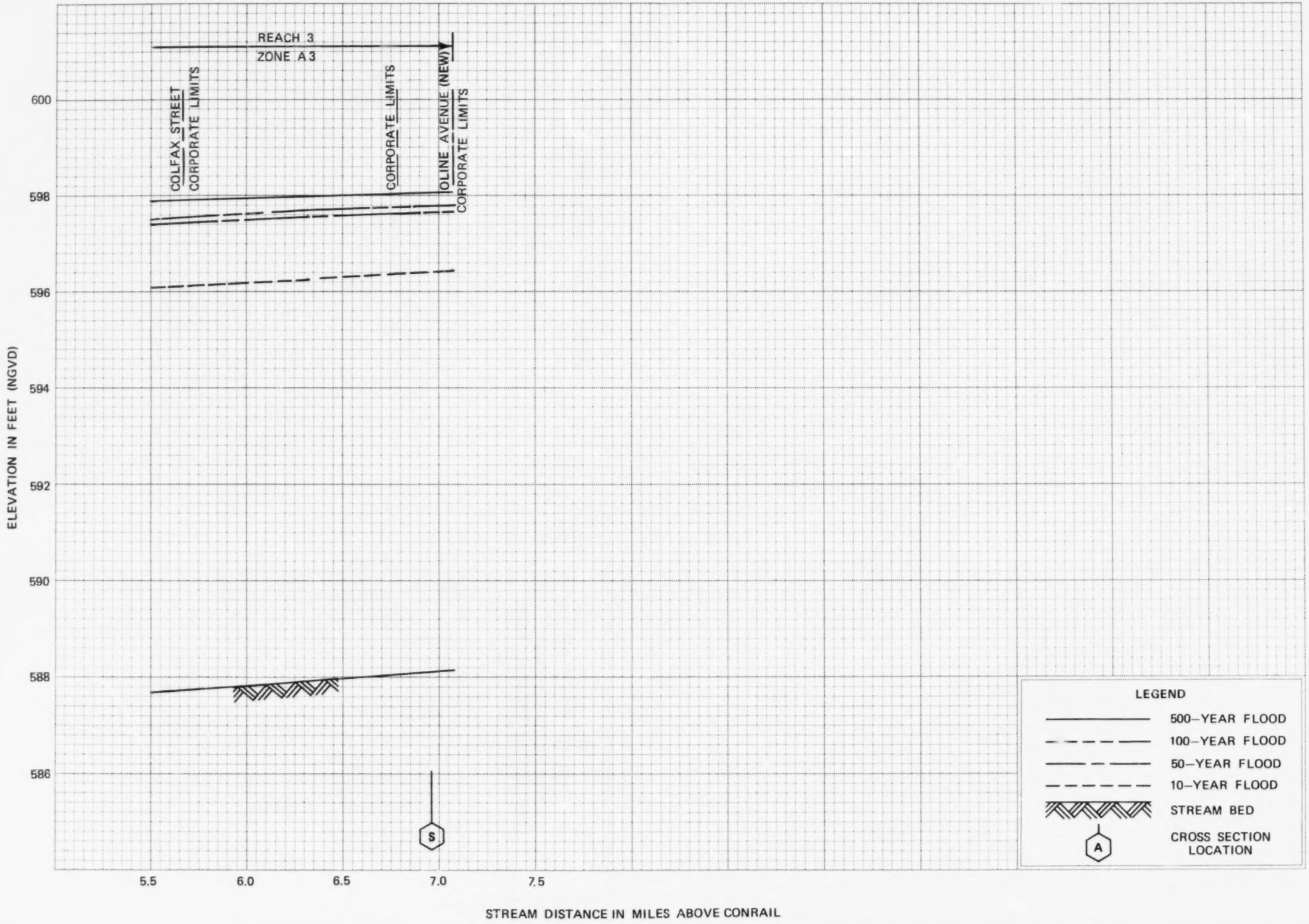
FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF GARY, IN
(LAKE CO.)

FLOOD PROFILES

LITTLE CALUMET RIVER



FLOOD PROFILES

LITTLE CALUMET RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF GARY, IN
(LAKE CO.)

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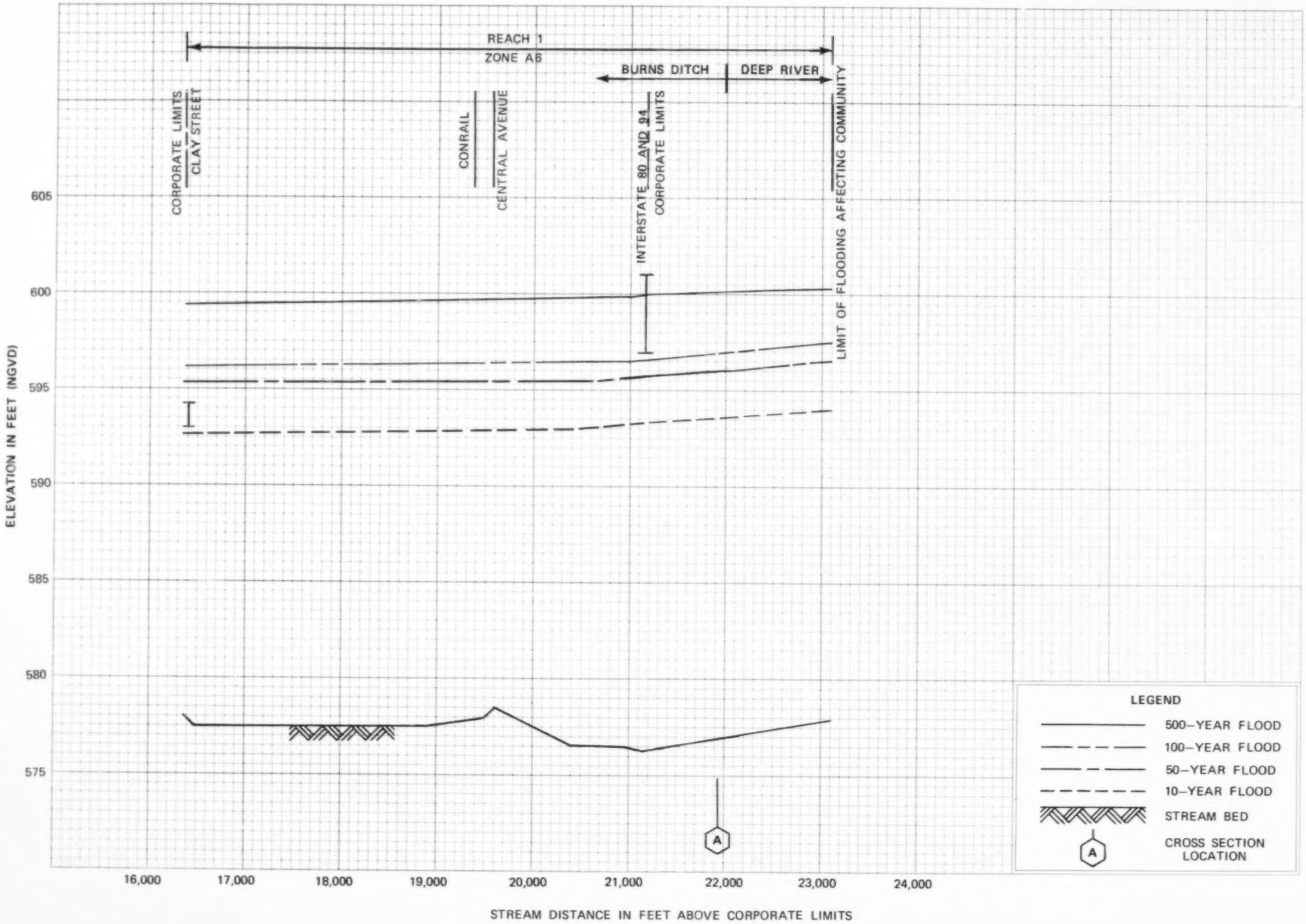

FLOOD PROFILES

BURNS DITCH - DEEP RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF GARY, IN
(LAKE CO.)

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